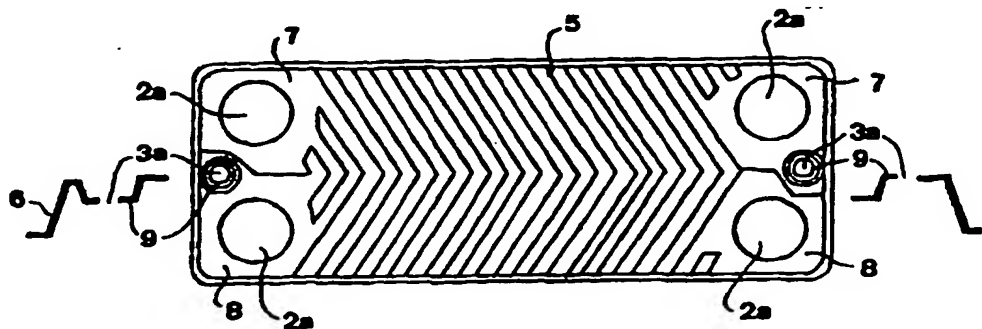


**PCT**WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>F28D 9/00, F28F 3/08 // 9/12</b>	<b>A1</b>	(11) International Publication Number: <b>WO 97/23759</b> (43) International Publication Date: <b>3 July 1997 (03.07.97)</b>
<p>(21) International Application Number: <b>PCT/SE96/01728</b></p> <p>(22) International Filing Date: <b>20 December 1996 (20.12.96)</b></p> <p>(30) Priority Data: <b>9504586-0</b>      <b>21 December 1995 (21.12.95)</b>      <b>SE</b></p> <p>(71) Applicant (for all designated States except US): <b>ALFA LAVAL AB [SE/SE]; S-147 80 Tumba (SE).</b></p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): <b>KÄLLROT, Karl, Magnus [SE/GB]; Autumn Rise, 2 Groove Lane, Wolverhampton WV6 8NJ (GB).</b></p> <p>(74) Agents: <b>BERGLUND, Stefan et al.; Bjerkéns Patentbyrå KB, Östermalmstorg 5, S-114 42 Stockholm (SE).</b></p>	<p>(81) Designated States: <b>CN, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b></p> <p><b>Published</b> <i>With international search report.</i></p>	

(54) Title: **A PLATE HEAT EXCHANGER**

## (57) Abstract

A plate heat exchanger comprises heat transfer plates (5) provided with port holes (2a). Said plates are compression-moulded relative to a reference plane and permanently joined to each other to a plate package to form heat transfer passages between adjacent heat transfer plates (5) and at least one port hole channel through said package. Said plates (5), through said compression-moulding, have contour portions (9) which through said permanent joining form areas of the plate package that lack any connection to said heat transfer passages. An aperture (3a) is made in each of said portions (9). Such apertures (3a) form at least one attachment member channel extending through the plate package and being adapted to receive an attachment member for attachment of the plate heat exchanger to a support mounting plate.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LJ	Liechtenstein	SI	Slovenia
CJ	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
	Estonia	MG	Madagascar	UA	Ukraine
	Spain	ML	Mali	UG	Uganda
	Iceland	MN	Mongolia	US	United States of America
		MR	Mauritania	UZ	Uzbekistan
				VN	Viet Nam

## 5    **A plate heat exchanger**

### TECHNICAL FIELD OF THE INVENTION AND PRIOR ART

10    The present invention refers to a plate heat exchanger comprising heat transfer plates provided with port holes, said plates being compression-moulded relative to a reference plane, and permanently joined to each other, for instance by brazing, to a plate package in such a manner that heat transfer passages are formed between adjacent heat  
15    transfer plates and at least one port hole channel is formed through said package by said port holes, wherein the heat transfer plates through said compression-moulding have been provided with contact portions which through said permanent joining of the plate package form areas of the plate package  
20    that lack any connection to said heat transfer passages.

Such brazed plate heat exchangers are used in a wide variety of applications, e.g. as oil coolers for vehicle engines. Problems occur when the plate heat exchanger is to be  
25    attached for instance to an engine or connection pipes with regard to the sealing between the plate heat exchanger and said engine or connection pipes around the port hole channels of the heat exchanger. Frequently, it is necessary to use further space requiring components, for instance  
30    brackets having a mounting loop to be tightened around the plate heat exchanger. Furthermore, it is possible to attach the plate heat exchanger by means of screws screwed into threaded holes in an end plate of the plate heat exchanger. Thereby, the end plate has to be more rigid and thicker than  
35    otherwise would have been the case. Besides the fact that these previously known methods of attaching a plate heat

exchanger involve the use of many further components, these methods also involve a time-consuming and labour-intensive mounting.

5 WO-A-9 417 354 discloses a plate heat exchanger having a stack of heat transfer plates clamped together by means of tie bars extending laterally of the heat transfer plates between two end plates. The area carrying the heat transfer medium between the heat transfer plates is sealed off by  
10 means of gaskets. Thus, by means of these gaskets heat transfer medium is prevented from penetrating an area near the periphery of the plates and in this area cut-outs have been made for tie bars and for rails by which the heat transfer plates may be suspended.

15 GB-A-2 208 005 discloses a similar plate heat exchanger having heat transfer plates clamped between two end plates and a small detection aperture in the periphery of the heat transfer plates outside the heat transfer area in order to  
20 detect a leakage in this area.

GB-A-1 275 711 discloses a similar plate heat exchanger having heat transfer plates clamped between two end plates and a small detection aperture in the periphery of the heat  
25 transfer plates outside the heat transfer area. In this aperture, being asymmetrically positioned, a thin bar is introduced to assure a proper orientation of the heat transfer plates during the mounting.

30 US-A-4 249 597 discloses a plate heat exchanger of another type having heat transfer plates brazed together in pairs. Thereafter, such pairs are stacked together and not brazed but clamped together by means of two bolts extending through the heat exchange plates, in order to provide a plate heat  
35 exchanger having double walls between the heat transfer passages.

GB-A-1 204 004 discloses a brazed plate heat exchanger comprising a package of heat transfer plates provided between enclosing casing parts. Furthermore, the heat  
5 exchanger comprises two locating pins provided in holes extending through the heat exchanger and functioning to position the different parts properly during the brazing process. During the brazing process the parts are drawn together by means of clips, whereafter all parts, i.e. the  
10 heat transfer plates, the casing parts and the locating pins, are heated and brazed together. In order to locate inlet and outlet pipes at the plate heat exchanger, a clip may be brazed to at least one of the casing parts.

#### 15 SUMMARY OF THE INVENTION

The object of the present invention is to provide a plate heat exchanger which in a simple and cost-effective manner may be attached to a support member or to a mounting plate.  
20 Furthermore, the invention aims at providing a plate heat exchanger having attachment means being as small and compact as possible.

This object is obtained by the plate heat exchanger  
25 initially defined and characterized in that an aperture is made in each of said contact portions and that such apertures form at least one attachment member channel extending through the plate package and being adapted to receive an attachment member for attachment of the plate  
30 heat exchanger to a support member or a mounting plate. By means of such an attachment member channel formed by the apertures it is possible to attach the plate heat exchanger to a support member in a simple and compact manner. It is also possible to connect the port hole channels of the plate  
35 heat exchanger to different types of fluid channels in a simple and compact manner. Therefore, the plate heat

exchanger need not be provided with a number of further, space requiring and expensive components for its connection and/or attachment.

5 According to one embodiment of the present invention, each of said contact portions is situated on a level differing from that of a surface portion at least partly surrounding the contact portion . Thereby, a contact portion of one heat transfer plate may be permanently joined to a contact  
10 portion of an adjacent heat transfer plate in such a manner that said attachment member channel is delimited from the heat transfer passages. This may be realized by the feature that a heat transfer plate comprises a first surface portion located at a first level and a second surface portion  
15 located at a second level, said first and second levels being situated on either side of said reference plane, and that in the area of said first surface portion at said first level, a contact portion is situated at said second level, and in the area of said second surface portion situated at  
20 said second level, a contact portion is situated at said first level. Furthermore, said contact portions of a first heat transfer plate are permanently joined to adjacent second and third heat transfer plates on respective sides of said first heat transfer plate.

25 According to another embodiment of the present invention and in order not to reduce the heat transfer area of the plate heat exchanger, at least one of said contact portions has a said aperture situated near the periphery of the relevant  
30 heat transfer plate.

According to a further embodiment of the present invention, at least one attachment member is provided to extend through said attachment member channel and arranged for said  
35 attachment of the plate heat exchanger to said support member or mounting plate. Such an attachment member may

comprise a bolt-like member extending through the attachment member channel for said attachment.

5 According to a further embodiment of the present invention, each heat transfer plate is elongated and has four port holes being provided in pairs with two port holes at each end of the heat transfer plate and there is provided one aperture between the port holes of each pair.

#### 10 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be explained more closely by means of different embodiments disclosed in the drawings attached hereto.

- 15 Fig 1 discloses a schematical view from above of a plate heat exchanger.
- Fig 2A discloses a side-view of the plate heat exchanger in Fig 1.
- Fig 2B discloses a sectional view of a part of the plate heat exchanger in Fig 2A.
- 20 Fig 3 discloses a view from above of a heat transfer plate.
- Fig 4 discloses a view from above of a heat transfer plate similar to the one in Fig 3.
- 25 Fig 5 discloses a view from above of a plate heat exchanger having a mounting plate for connection pipes.
- Fig 6 discloses a view from the short side of the plate heat exchanger in Fig 5.
- 30 Fig 7 discloses a connection pipe.
- Fig 8 discloses a side-view similar to the one in Fig 6 of an alternative embodiment.
- Fig 9 discloses a side-view of a plate heat exchanger being attached to a base member.
- 35 Fig 10 discloses a side-view similar to the one in Fig 6 of an alternative embodiment.

Fig 11        discloses an alternative connection pipe.

#### DETAILED DESCRIPTION OF DIFFERENT EMBODIMENTS

5    Figs 1, 2A and 2B disclose an elongated plate heat exchanger 1 having four port hole channels 2, forming the inlet and the outlet respectively, for the heat transfer passages for two media to be conducted through the plate heat exchanger 1. The four port hole channels 2 of the plate heat exchanger 1 are provided in pairs with two port hole channels 2 at 10 each end. Between each pair of port hole channels 2 an attachment member channel 3 extends through the plate heat exchanger 1. The attachment member channel 3 is located in an area of the plate heat exchanger 1 which none of the heat 15 transfer media may reach. Through the attachment member channel 3 an attachment member 4 such as a bolt-like member extends for different attachment purposes to be described more closely below. The plate heat exchanger 1 comprises a great number of heat transfer plates 5 stacked together to 20 form a plate package. The heat transfer plates 5 are compression-moulded relative to a reference plane, and have a pattern more closely disclosed in Figs 3 and 4, in two different but similar kinds. Each heat transfer plate 5 has a relatively elongated shape with two port holes 2a and one 25 aperture in the form of a hole 3a at each short side. Furthermore, each heat transfer plate 5 comprises a downwardly bent edge 6, a first surface portion 8 at a first level with respect to said reference plane and a second surface portion 7 at a second level with respect to said 30 reference plane. The first and second surface portions 8, 7 are situated on either side of said reference plane. The heat transfer passages are formed by means of the arrow pattern disclosed in Figs 3 and 4 in such a manner that the heat transfer plates 5 are stacked with the arrow pattern in 35 each second heat transfer plate 5 directed to the right and in the remaining plates directed to the left. Around the



hole 3a each heat transfer plate 5 has a contact portion 9, being located on a level differing from that of the surrounding surface portion 7, 8. Consequently, when the hole 3a is situated at the second surface portion 7 at the second level, the surface of the contact portion 9 is situated at the same level as the first surface portion 8, and when the hole 3a is situated at the first surface portion 8 at the first level, the surface of the contact portion 9 is situated at the same level as the second surface portion 7. When the plates 5 are stacked according to the method described above and brazed together, the contact portions 9 will, as is disclosed in the magnified section view of Fig 2B, abut each other and provide an area which is not accessible from any of the heat transfer passages. Because of this, it is thus possible to provide a hole 3a in the centre of the contact portion 9 without any risk for leakage. Thus, the holes 3a of the heat transfer plates 5 stacked together form the attachment member channel 3.

Figs 5 to 8 disclose how the plate heat exchanger 1 is connected to connection pipes 10 via the port hole channels 2 for the in-flow and out-flow, respectively, of heat transfer medium to and from the heat transfer passages of the plate heat exchanger 1. Each connection pipe 10 comprises a flange 11 projecting radially and, in the example disclosed, extending around the whole periphery of the connection pipe 10. Below the flange 11 the connection pipe 10 has a continuing portion 12 having such a diameter that it precisely may be introduced into one of the port hole channels 2. Around the continuing portion 12 a sealing ring 13 is provided, which in the example disclosed is in the form of an O-ring. Consequently, when the continuing portion 12 of the connection pipe 10 is introduced into a port hole channel 2 the sealing ring 13 will abut an outermost plate 15. The two outermost plates are called the

end plates 14 and 15 and have a somewhat greater thickness of material than the heat transfer plates 5. A mounting plate 16 is positioned on the connection pipes 10. The mounting plate 16 comprises a projecting portion 17  
5 projecting from one surface of the mounting plate 16 about as much as the height of the flange 11 and abutting the end plate 15. Besides openings for the connection pipes 10, a hole 18 is made in the mounting plate 16, which extends through the mounting plate 16 in the area of the projecting  
10 portion 17. In order to sealingly connect the connection pipes 10 to the plate heat exchanger 1 the bolt-like member, which in the example disclosed is comprised of a threaded bolt 19, is introduced through the hole 18 and the attachment member channel 3 and by means of a nut 20 the  
15 mounting plate 16 and thus the flanges 11 with the sealing rings 13 are tightened against the end plate 15 of the plate heat exchanger 1. Between the nut 20 and the end plate 14 a strengthening washer 21 may be provided. Of course, the bolt 19 may be introduced from the other side, in which case the  
20 nut 20 will be located on the same side as the mounting plate 16. The disclosed bolt 19 having a screw and a nut may also be comprised of other bolt-like members, for example a bar having fixed heads, a bar extending through the plate heat exchanger 1 and welded to the end plates 14, 15, etc.  
25 The mounting plate 16 may be shaped in many different ways, for example as disclosed to the left in Fig 5 where the openings of the mounting plate 16 are in the form of recesses, which is advantageous in the cases when the connection pipes 10 are fixed and thus may not be introduced  
30 into holes in the mounting plate 16 as disclosed to the right in Fig 5. Furthermore, the mounting plate 16 may be configured as individual plates for each connection pipe 10 or as one single plate for all connection pipes 10.

35 Fig 8 discloses an attachment member channel in the form of a groove formed by recesses or cut-outs 22a in the end

portions of each heat transfer plate 5. Such a cut-out 22a, which is disclosed by dotted lines in Fig 4, is surrounded in the same way as the hole 3a of a corresponding contact portion 9. Thus, also the cut-outs 22a of the heat transfer plates 5 stacked together form an attachment member channel 22 which is delimited from the heat transfer passages of the plate heat exchanger 1 and through which the bolt 19 extends. It should also be noted that the hole 3a or the cut-out 22a not necessarily have to be provided between a pair of port holes 2a. According to the present invention, it is for example possible to provide a plate heat exchanger 1 with only one attachment member channel 3 situated in the centre thereof.

Fig 9 discloses another way of arranging the plate heat exchanger 1 according to the present invention. In this example the plate heat exchanger 1 is directly attached to a schematically disclosed support member 23, which for example may be a part of a vehicle engine. Through the support member connection channels 24 extend in alignment with the port hole channels 2 of the plate heat exchanger 1. In order to obtain a proper sealing of the connection between the port hole channels 2 and the connection channels 24 a gasket 25 is provided between the plate heat exchanger 1 and the support member 23. In this case the plate heat exchanger 1 is attached in a particularly simple manner by bolts 19 extending through the attachment member channel of the plate heat exchanger 1 and being screwed to threaded holes 26 in the support member 23. It should be noted that the gasket 25 also may be provided as individual gaskets, one for each port hole channel 2.

Figs 10 and 11 disclose an alternative way of connecting a connection pipe 10 to the port hole channel 2 of the plate heat exchanger 1. Around the connection pipe 10 a conically tapered sealing ring 27 is provided. A mounting plate 28

- having openings 29 being conically tapered in a corresponding way, is tightened against the plate heat exchanger 1 by means of the bolt 19 such that the sealing ring 27 may be pressed against the end plate 15 and the connection pipe 10 and thus connect the pipe 10 to the plate heat exchanger 1. Simultaneously, an effective sealing of the connection between the port hole 2 and the connection pipe 10 is obtained.
- 10 The plate heat exchanger according to the present invention may be utilized in many different applications where it is essential to keep the cost of mounting and the components on a low level. Besides the application for combustion engines the plate heat exchanger according to the present invention
- 15 may also for example be used in oil coolers for gear boxes or compressors, for hot water heaters or for central heating devices etc.

Claims

1. A plate heat exchanger (1) comprising heat transfer plates (5) provided with port holes (2a), said plates (5) being compression-moulded relative to a reference plane, and permanently joined to each other, for instance by brazing, to a plate package in such a manner that heat transfer passages are formed between adjacent heat transfer plates (5) and at least one port hole channel (2) is formed through said package by said port holes (2a), wherein the heat transfer plates (5) through said compression-moulding have been provided with contact portions (9) which through said permanent joining of the plates (5) in the plate package form areas of the plate package that lack any connection to said heat transfer passages, characterized in that an aperture (3a, 22a) is made in each of said contact portions (9) and that such apertures (3a, 22a) form at least one attachment member channel (3, 22) extending through the plate package and being adapted to receive an attachment member (4, 19) for attachment of the plate heat exchanger (1) to a support member (23) or a mounting plate (16, 28).

2. A plate heat exchanger according to claim 1, characterized in that each of said contact portions (9) is situated on a level differing from that of a surface portion (7, 8) at least partly surrounding the contact portion (9).

3. A plate heat exchanger according to claim 2, characterized in that a contact portion (9) of one heat transfer plate (5) is permanently joined to a contact portion (9) of an adjacent heat transfer plate (5) in such a manner that said attachment member channel (3, 22) is delimited from the heat transfer passages.

4. A plate heat exchanger according to any one of claims 2 and 3, characterized in that a heat transfer plate (5) comprises a first surface portion (8) located at a first level and a second surface portion (7) located at a second level, said first and second levels being situated on either side of said reference plane, and that in the area of said first surface portion (8), at said first level, a contact portion (9) is situated at said second level, and in the area of said second surface portion (7) situated at said second level, a contact portion (9) is situated at said first level.

5. A plate heat exchanger according to claim 4, characterized in that said contact portions (9) of a first heat transfer plate (5), are permanently joined to contact portions (9) of adjacent second and third heat transfer plates (5) on respective sides of said first heat transfer plate (5).

6. A plate heat exchanger according to any one of the preceding claims, characterized in that at least one of said contact portions (9) has a said aperture (3a, 22a) situated near the periphery of the relevant heat transfer plate (5).

7. A plate heat exchanger according to any one of the preceding claims, characterized by at least one attachment member (4, 19) extending through said attachment member channel (3, 22) and arranged for said attachment of the plate heat exchanger (1) to said support member (23) or mounting plate (16, 28).

8. A plate heat exchanger according to claim 7, characterized in that the attachment member comprises a bolt-like member (19) extending through the attachment member channel (3, 22) for said attachment.

9. A plate heat exchanger according to any one of the preceding claims, characterized in that each heat transfer plate (5) is elongated and has four port holes (2a) being provided in pairs with two port holes (2a) at each end of the heat transfer plate (5) and that there is provided one aperture (3a, 22a) between the port holes (2a) of each pair.

Fig 1

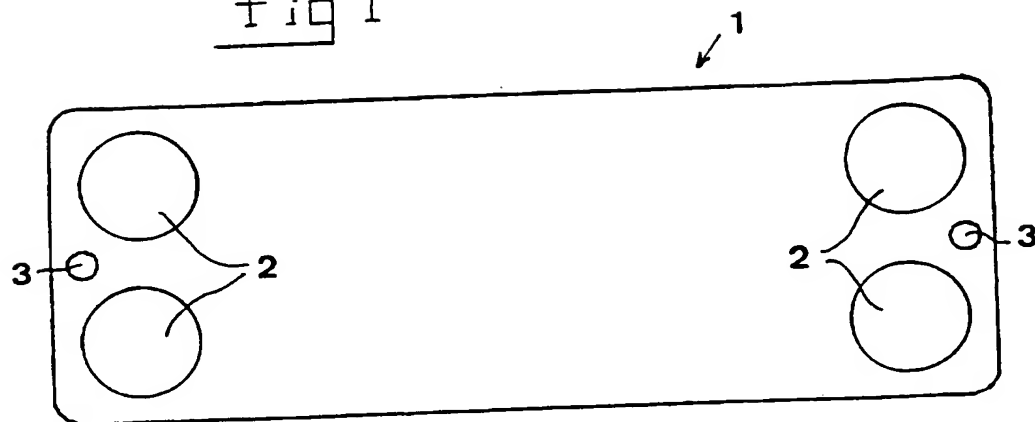


Fig 2A

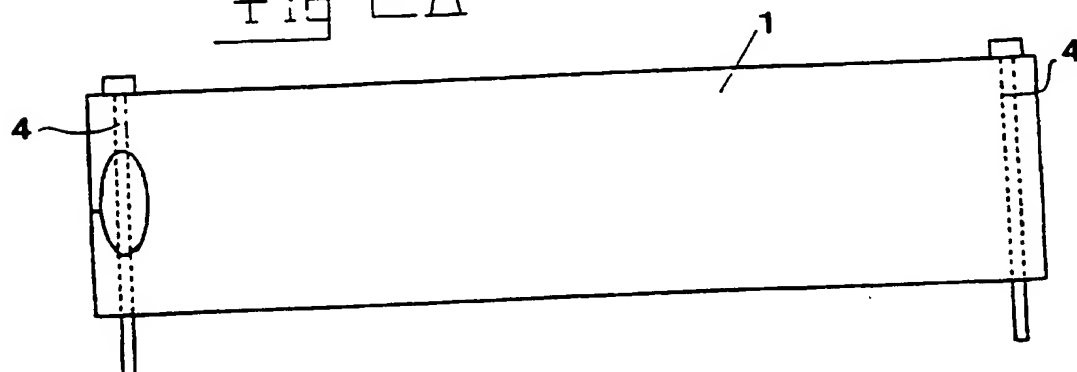


Fig 2B

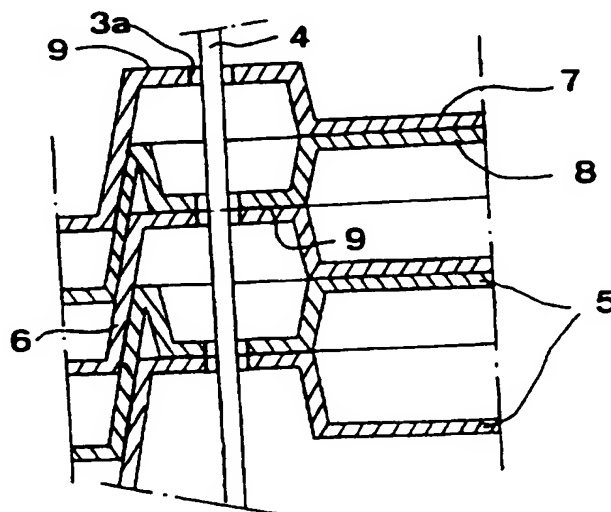




Fig 3

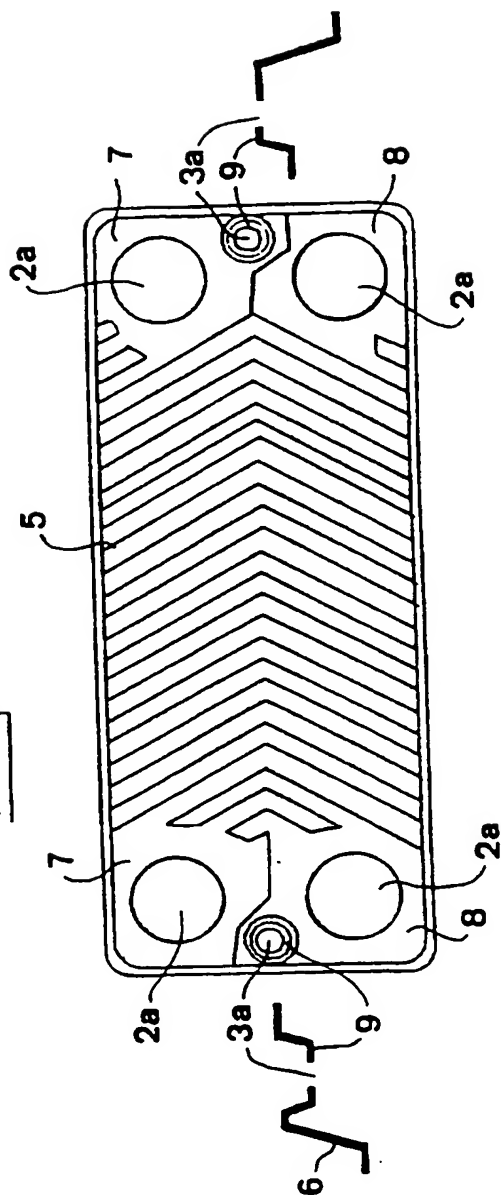


Fig 4

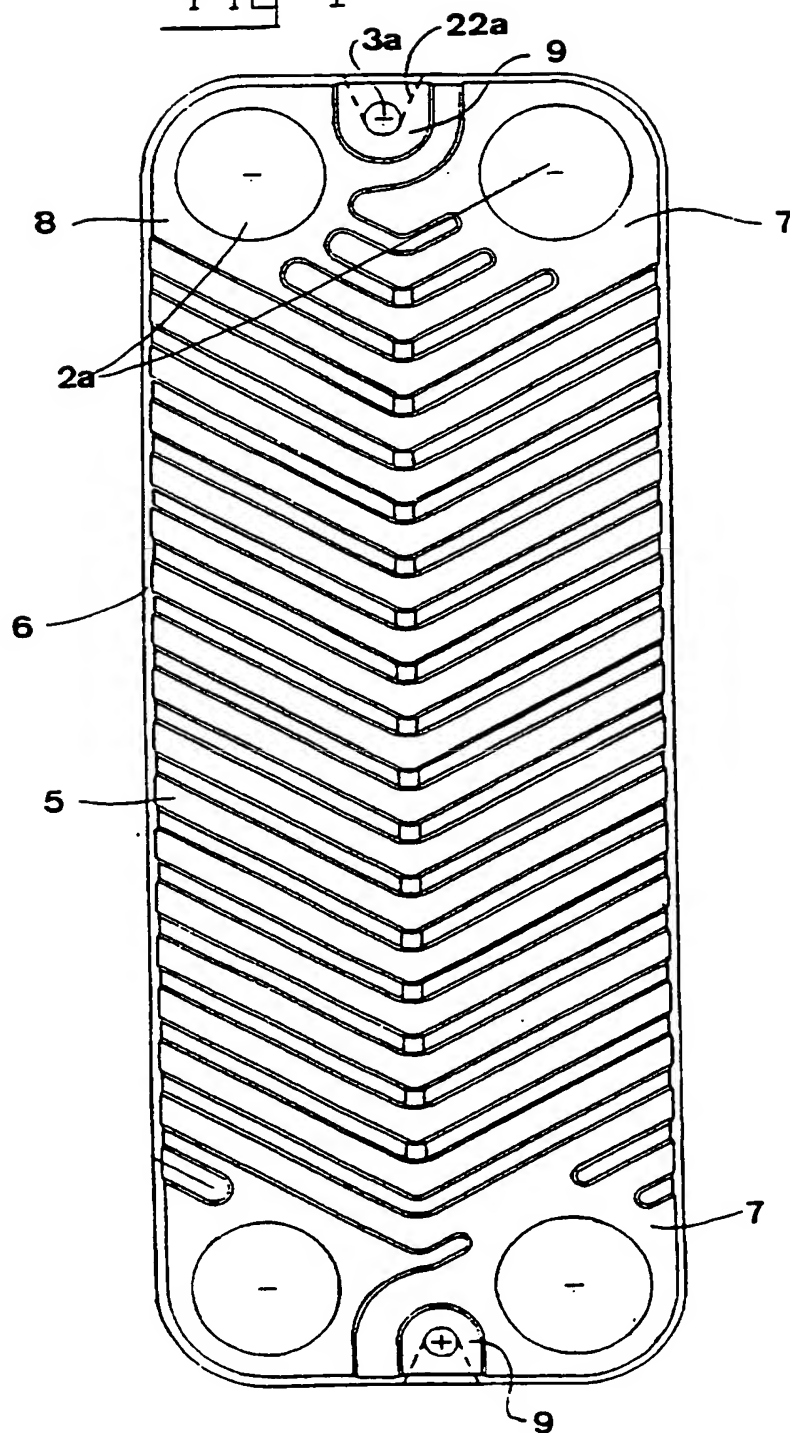


Fig 5

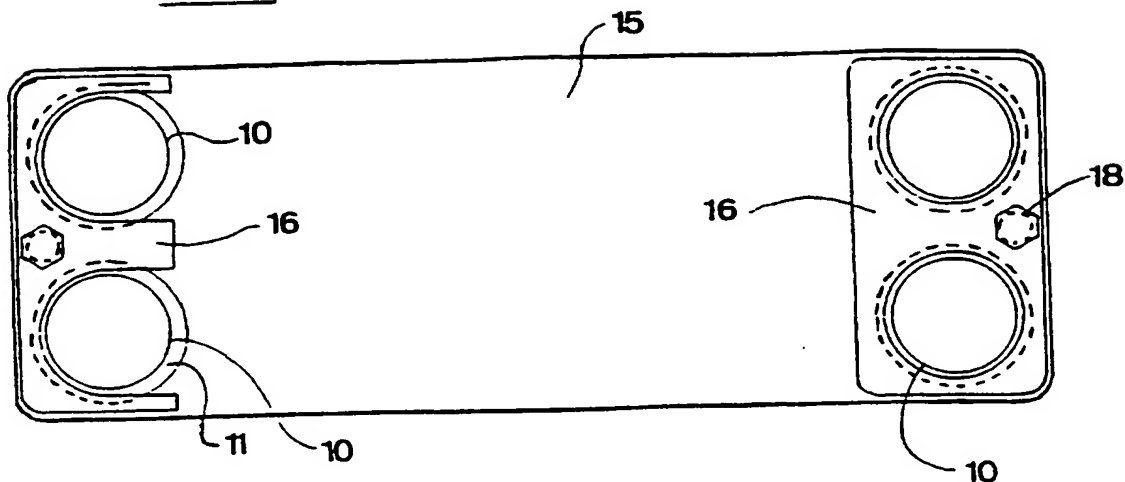


Fig 6

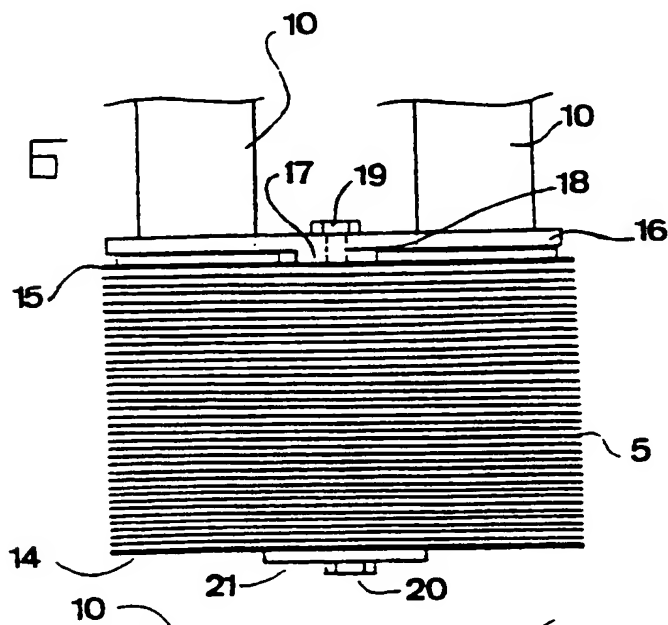


Fig 7

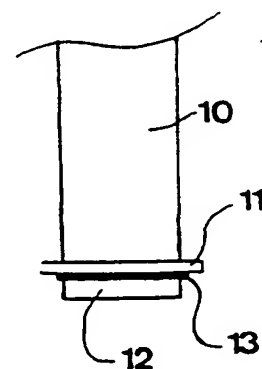
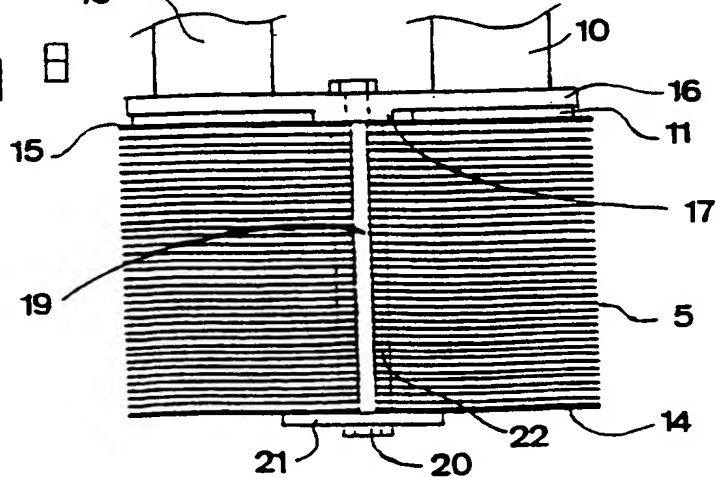


Fig 8



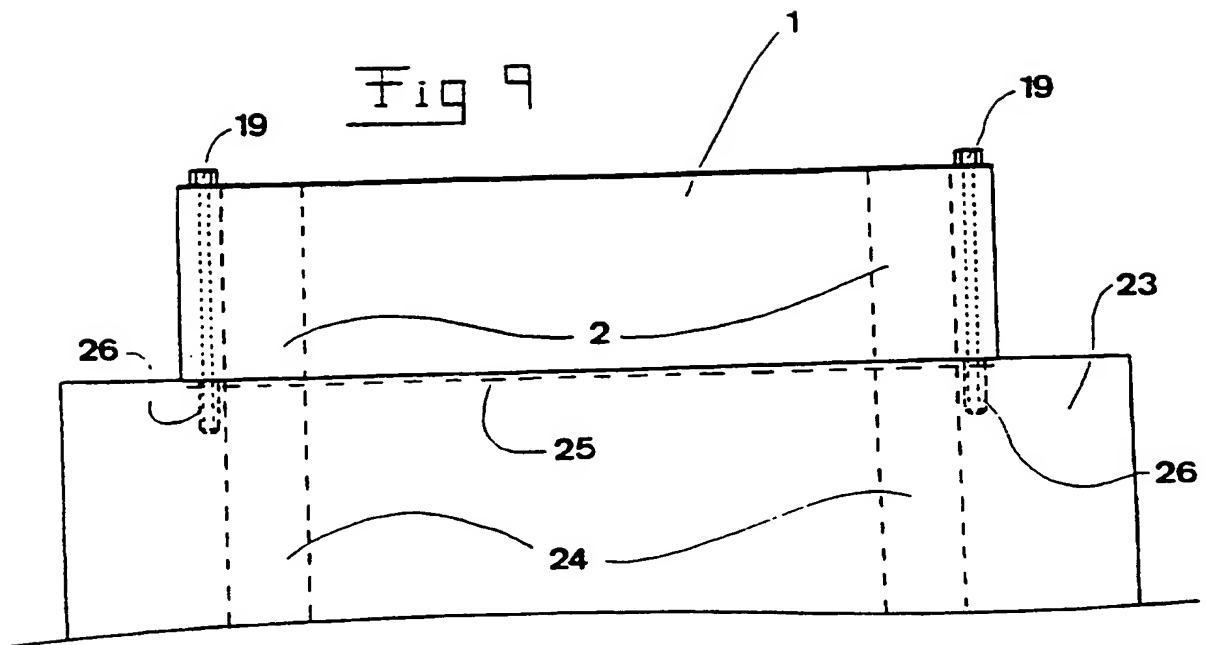


Fig 10

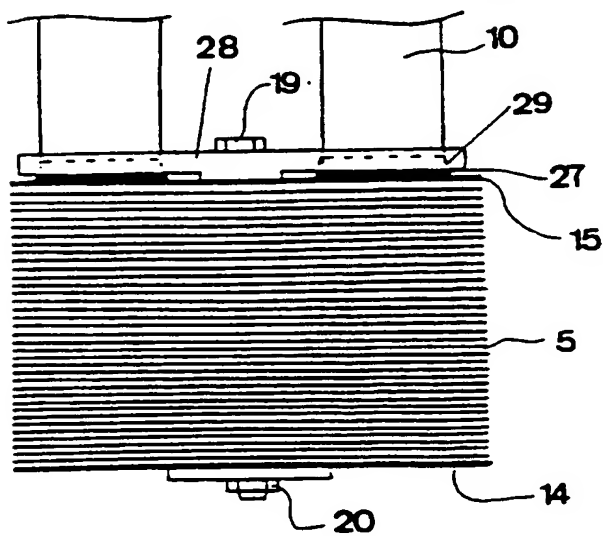
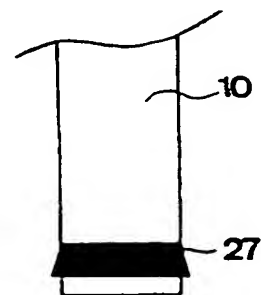


Fig 11



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 96/01728

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F28D 9/00, F28F 3/08 // F28F 9/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F28D, F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4249597 A (CAREY), 10 February 1981 (10.02.81) --	1,3,6-9
A	US 4872578 A (FUERSCHBACH ET AL), 10 October 1989 (10.10.89) --	2,4,5
A	US 2648527 A (O.A. CARNAHAN), 11 August 1953 (11.08.53) --	3,8
A	US 5307869 A (BLOMGREN), 3 May 1994 (03.05.94) -- -----	8



Further documents are listed in the continuation of Box C.



See patent family annex.

## \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

14 March 1997

Date of mailing of the international search report

05 April 1997 (05.04.97)

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer

Magnus Thorén  
Telephone No. +46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

04/03/97

International application No.  
PCT/SE 96/01728

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US-A-	4249597	10/02/81	NONE		
US-A-	4872578	10/10/89	CA-A-	1284316	21/05/91
			DE-U-	6890278	15/10/92
			EP-A,B-	0347961	27/12/89
			SE-T3-	0347961	
			JP-C-	1867585	26/08/94
			JP-A-	2169993	29/06/90
US-A-	2648527	11/08/53	NONE		
US-A-	5307869	03/05/94	DE-D,T-	69016044	11/05/95
			DE-D,T-	69106125	04/05/95
			EP-A,B-	0500735	02/09/92
			EP-A,B-	0517785	16/12/92
			SE-T3-	0517785	
			NO-B,C-	176268	28/11/94
			SE-A-	9000712	29/08/91
			WO-A-	9113308	05/09/91
			SE-B,C-	468070	26/10/92
			SE-A-	9100048	09/07/92